98TH CONGRESS | HOUSE OF REPRESENTATIVES | REPORT
1st Session | | No. 98-510

SATELLITE-DIRECTED NAVIGATIONAL GUIDANCE FOR AIRCRAFT

NOVEMBER 8, 1983.—Referred to the House Calendar and ordered to be printed

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Mr. FUQUA, from the Committee of Science and Technology, submitted the following

REPORT

[To accompany H. Con. Res. 190]

The Committee on Science and Technology, to whom was referred the resolution (H. Con. Res. 190) expressing the sense of the Congress that the Secretary of Transportation should submit to the Committee on Science and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate full research and development program planning documentation leading to expedited use by the civilian sector of certain satellite-directed navigation aids developed by the Department of Defense for the guidance of aircraft, having considered the same, report favorably thereon without amendment and recommend that the resolution do pass.

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I. BACKGROUND

Current Global Navigation Systems

International Civil Aviation Organization (ICAO) standards require an aircraft, which is not under visual flight (VFR) rules, to

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have "navigation equipment which will enable it to proceed; (a) in accordance with its operational flight plan; and (b) in accordance with the requirements of air traffic services . . ." Federal Aviation Administration standards are more specific, but permit the use of several different types of navigation equipment for oceanic use, including Doppler radar, Inertial Navigation Systems (INS), Omega, Loran and/or a professional navigator.

The Doppler radar navigation system is entirely self-contained in the aircraft and relies on up to four radar beams of a known frequency which are splayed onto the earth's surface beneath the aircraft. As the beams are reflected back to the aircraft the frequencies of the forward beams are increased, and the frequencies of the rearward beams are reduced, in proportion to the component of the speed in each direction. By analyzing the frequency of the radar energy reflected back from the ground, the radar's computer can determine data such as the speed of the aircraft across the ground and the angle of drift caused by winds. Using this information the computer determines geographic position referenced to a verified fix on the ground. Doppler navigation system accuracy tends to degrade at a rate of one-half mile per hour of operation along its track, and at 2 percent of the distance traveled across its track.

The heart of an Inertial Navigation System (INS) is a carefully balanced platform, held level by gyroscopes, on which three accelerometers are mounted, each pointing in a different direction: fore and aft, up and down, left and right. They measure the aircraft's slightest acceleration, and this is automatically converted to velocity and then to distance covered. On takeoff the aircraft's exact position is programmed into the system, and thereafter a panel display shows the aircraft's position continuously throughout the flight. It is usual for large airliners to carry three INS sets so that the crew can check discrepancies by comparing the three position indicators. Inertial navigation systems accuracy tends to decrease at a rate of one mile per hour of operation.

The Omega system was originally set up by the U.S. Navy and currently is operated by the Coast Guard in cooperation with several other participant nations. Omega, whose accuracy surpasses that of the INS for long range, relies on Omega transmitters in each hemisphere which send out powerful long-wave radio signals that can be picked up by aircraft as well as by ships and submarines. Within a ten-second interval, each station transmits three pulses, each on a different radio frequency and lasting for approximately one second. All the signals are synchronized, and super-accurate atomic clocks keep their transmissions in time. A miniature computer on the aircraft analyzes the signals and calculates its position anywhere in the world to an accuracy of within two miles. Omega provides worldwide position determination for civil and military aviation and marine users.

A long range navigation system developed by the military for use during World War II (LORAN-A) and later adopted for use by civil aviation and marine use is currently being expanded and modernized. The new system (LORAN-C) was developed by the Defense Department to provide military users with a radionavigation capability having much greater accuracy than LORAN-A. In 1974, LORAN-C was designated as the U.S. Government-provided naviga-

tional system for the U.S. coastal areas. LORAN-C relies on the transmission of synchronized pulses or continuous radio waves whose regular interference with one another sets up a complicated but predictable pattern which is always stationary relative to the ground. Using this pattern as a reference which can be picked up by an aircraft radio receiver, relative position can be calculated. Because of system reliability and technological advances which are lowering the costs of user equipment, civil use of LORAN-C is increasing rapidly. The LORAN-C system is currently capable of providing coverage for about 15 percent of the earth's surface, and has an accuracy of about one-quarter of a mile.

Satellite Directed Navigation: The Global Positioning System

A satellite directed navigation system developed by the Department of Defense, the NAVSTAR Global Positioning System (GPS), is based on the use of 18 or possibly 24 satellites orbiting at an altitude of 10,900 nautical miles. The spacing and elevation is such that, when the constellation is fully configured, three or more satellites will be visible at all times anywhere in the world. Each satellite transmits a composite signal which contains data such as the satellite's position and exact time, atmospheric propagation correction data, and satellite clock bias information provided by an atomic clock at a master control ground station. This information is used to calculate position, velocity, and time. The Global Positioning System is capable of providing three-dimensional positioning and guidance in the air and two-dimensional positioning and guidance on the ground to an accuracy of 15 meters.

The NAVSTAR-GPS program of the Department of Defense is currently in the full scale development phase with six GPS satellites in orbit for operational testing. Production prototypes of the user equipment are currently being evaluated. The GPS system is scheduled to be fully operational in 1988, with the first operational satellite scheduled to be launched in 1986.

While the basic purpose of NAVSTAR-GPS is to serve U.S. military forces in navigation, guidance, and delivery applications, the capabilities of the system offer many advantages to civil aviation, particularly for more accurate oceanic navigation and more efficient use of airspace.

In response to the recent Korean jetliner tragedy, the White House released a statement on September 16, 1983, announcing that the GPS radionavigation system will be made available for civil purposes worldwide to avoid such disasters in the future. Federal Aviation Administrator, J. Lynn Helms, conveyed the same message at the International Civil Aviation Organization's meeting in Montreal, indicating that the system would be available for international use in 1988.

Although the White House considered including an additional statement indicating the GPS would be available to the world free of charge, it was not included in the announcement. The issue of "user fees" for civil use of GPS has continued to be a major barrier to its acceptance by the civil aviation community. The FAA remains strongly opposed to GPS user fees because of the severe potential impact on aviation safety should an aircraft relying on GPS fail to purchase the equipment needed on an annual basis to deci-

pher the encrypted GPS signal. The FAA has also cited the difficulty of encouraging international acceptance of GPS if the U.S. charges other nations for navigation services that are available elsewhere free of charge. The FAA also notes that U.S. civil aviation already pays user fees under the Airport and Airways Improvement Act tax. The Defense Department was requested by Congress in 1982 (H. Rpt. 97-311 and S. Rpt. 97-273) to formulate a plan to make NAVSTAR-GPS available to non-defense users that would provide for recouping as much of GPS's cost as deemed feasible. However, at a September 19, 1983 hearing of the Transportation, Aviation and Materials Subcommittee, a representative of the Defense Department indicated that the problem of collecting user fees worldwide is ". . . a very difficult, mind-boggling job." It should also be recognized that, to date, the U.S. has never sought cost recovery through the direct assessment of charges for the use of a federal radionavigation system.

Under the original proposal to allow the use of the Global Positioning System by civil aviation and other non-defense users, the Department of Defense planned to degrade the accuracy of the standard positioning service signal as a security precaution. Thus, civil GPS users would be limited to the use of a signal providing an accuracy of 500 meters, while Defense Department users would be able to use the signal giving an accuracy of 15 meters. The 500 meters horizontal accuracy is insufficient for non-precision approach and landing operations under present FAA and ICAO standards. In response to the lack of acceptance of the 500 meters accuracy, the Department of Defense has indicated that they will allow the broadcast of signals to provide an accuracy of 100 meters. Non-military users may also be allowed to use the signal which provides the 15 meter accuracy if they can securely lock up receivers equipped with the required decoding chips. The Defense Department's tentative proposal would charge users $370 a year for the 100-meter accuracy level and $3,700 a year for the civilians who would be eligible to receive the 15-meter accuracy level.

II. EXPLANATION AND PURPOSE OF THE RESOLUTION

The Subcommittee on Transportation, Aviation and Materials has jurisdiction over the authorization of funds for the research and development programs of the Federal Aviation Administration. As a part of the FAA's long-term R&D planning, the FAA is a participant in the DOD/DOT Interagency Agreement to establish a unified national navigation policy to avoid the proliferation of navigation systems. Under the current Federal Navigation Plan (March 1982), the FAA does not contemplate any civil users of the Global Positioning System (GPS) through 1995 and does not include GPS in its planning. However, the Department of Defense contemplates the phasing out of almost all navigation systems except ILS/MLS in favor of GPS from about 1987 to the turn of the century.

The Global Positioning System offers a number of advantages over the currently available navigation systems. GPS coverage is world-wide and much more accurate than the various alternatives. GPS has the capability to function without the line-of-sight (radio horizon) limitations inherent in other systems. GPS is impervious

to atmospheric conditions so it can provide uninterrupted operation. Benefits to civil aviation from GPS would include increased safety and more efficient use of the airspace.

Following the recent tragedy in which a Korean airliner was shot down by a Soviet fighter after straying over airspace of the Soviet Union, the White House and the FAA announced that GPS would be made available for civil aviation users by 1988. However, as yet, the FAA has not submitted a detailed research and development program plan for the expedited use of GPS by civil aviation. The purpose of this resolution is to express the sense of Congress that such plan should be submitted to the appropriate Committees in order to facilitate expedited civil use of GPS navigation technology.

III. CONGRESSIONAL BUDGET OFFICE ESTIMATES

No information pursuant to Section 403 of the Congressional Budget Act of 1974 has been provided to the Committee on Science and Technology by the Congressional Budget Office as of Nov. 8, 1983.

IV. COMMITTEE RECOMMENDATION

A quorum being present, the Committee ordered favorably reported the resolution by voice vote of those present.

V. COMMITTEE OVERSIGHT—FINDINGS AND RECOMMENDATIONS

Pursuant to rule XI, clause 2(l)(3) of the Rules of the House of Representatives, and under the authority of rule X, clause 2(b)(1) and clause 3(f), no findings and recommendations are under consideration by the Committee on Science and Technology on satellite-directed navigation systems.

VI. OVERSIGHT FINDINGS AND RECOMMENDATIONS, COMMITTEE ON GOVERNMENT OPERATIONS

Pursuant to rule X, clause 2(b)(2) and rules XI, clause 2(l)(3), of the Rules of the House of Representatives, no findings or recommendations on oversight activity have been submitted by the Committee on Government Operations for inclusion in this report.

VII. INFLATION IMPACT OF BILLS AND JOINT RESOLUTIONS OF PUBLIC CHARACTER

In accordance with rule XI, clause 2(l)(4), of the Rules of the House of Representatives, this joint resolution is assessed to have no adverse inflationary effect on prices and costs in the operation of the national economy.

VIII. COMMITTEE COST ESTIMATE ON BILLS OR JOINT RESOLUTIONS OF PUBLIC CHARACTER

In accordance with the requirements of section 252(b) of the Legislative Reorganization Act of 1970 and pursuant to rule XIII, clause 7 of the Rules of the House of Representatives, the committee expects that no additional cost will be incurred by the Federal

Government during the current and five subsequent years as a result of the enactment of this joint resolution.

Fiscal year:	*Dollars*
1984	0
1985	0
1986	0
1987	0
1988	0

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